

A STUDY ON THE EFFECTIVENESS OF MIRROR BOX THERAPY ON HAND FUNCTION IN PATIENTS WITH HEMIPLEGIA



Register Number: - 27072103

A Dissertation Submitted in partial fulfillment of the requirements for the degree of
Master of physiotherapy (M.P.T) to the Tamil Nadu
Dr.M.G.R Medical University, Chennai – 600032.
MARCH-2011

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**ADHIPARASAKTHI COLLEGE OF PHYSIOTHERAPY
MELMARUVATHUR - 603 319, KANCHIPURAM DISTRICT,
TAMILNADU.**

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DECLARATION

I hereby declare and present my dissertation titled **A Study on the Effectiveness of Mirror Box Therapy On Hand Function in Patients with Hemiplegia.**

The outcome of original research work was undertaken and carried out by me, under the guidance of. **Dr. Bharath M.P.T.** Adhiparasakthi College of Physiotherapy, Melmaruvathur, Kancheepuram District, Tamil Nadu. I also declare that the material of this dissertation has not formed in any way the basis for the award of any other degree previously from the Tamilnadu Dr. M.G.R, Medical University, Chennai.

Register No: 27072103

ACKNOWLEDGEMENT

With the divine blessings of His Holiness **ARUL THIRU AMMA and THIRU MATHI AMMA**, I take immense pleasure in submitting this dissertation work.

I am grateful to our principal Dr. s. Nagarajan M.P.T (sports) who have galvanized me throughout the dissertation work.

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I am indebted to my parents, family and my friends for their prayerful support, inspiration, love, and encouragement through this Endeavour.

My most sincere appreciation to those who mean the most to me

Finally I express personal thanks to all my parents who cooperated during treatment programme.

I dedicated this dissertation work to the **LOTUS FEET OF ARUL THIRU AMMA.**

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INTRODUCTION

INTRODUCTION

Stroke causes a major impairment and functional disability in millions of people. It has been noted that the incidence may vary considerably from country to country. The prevalence of stroke in India was estimated as 203 per 100,000 populations.

According to the National Institute of Neurologic Disorders and Stroke (USA) "Stroke is a sudden loss of brain function resulting from an interference with blood supply to the brain".

A working brain consists of 100 billion neurons (more than all the stars in the Milky Way), each connected to as many as 10,000 other neurons, the entirety combining to produce more possible states of mind than the estimated number of elementary particles in the known universe.

Stroke causes a massive distortion of the capacity of the brain to process neural information, with heterogeneous consequences. After a stroke, not only the motor system is affected, but also the cognitive and emotional systems may be seriously impaired.

Motor disorders are a frequent consequence of stroke and much effort is invest in the re-acquisition of motor control. Although patients often regain some of their lost function after therapy. But most of them remain chronically disabled.

Functional recovery is achieved largely through reorganization processes in the damaged brain. Neural reorganization depends on the information provided by sensorimotor efferent-afferent feedback loops.

Now the Stroke rehabilitation has been revolutionized through a combination of new technique looking at brain recovery. It has been shown that the motor system can also be activated by imagining (motor imagery) or observing movements.

One of the newest therapies currently under study is Mirror box therapy. It is a form of imagery technique in which a mirror is use to convey visual stimuli to the brain.

PRINCIPLE: The underlying principle of mirror box therapy is that movement of the affected limb can be stimulated via visual cues originating from the opposite side of the extremity. The mirror produces a "stereoisomeric image.

It helps to restore the movements by activation of mirror neurons. Mirror neurons fire when not only an action is executed, but also when one observes another person performing the same action, neuro plastic changes occur within the brain.

SIGNIFICANCE OF THE HUMAN HAND

Man is born with a free hand to do the bidding of his expanded brain.

The elaborated nervous system of human brain, which coordinates eye and hand. He uses it as a tool, as a symbol, and as a weapon.

The Hand as a Sensory Organ

Although prehension is the major function of the hand, the hand is, at the same time, one of man's primary sense organs. This tactile quality provides sensory experience that may be grouped into four general categories they are

1. Surface sensations -The stimulation generated by touching tangible objects.

2. space-filling - The stimulation generated by pulling the hand through liquid substance.
3. Space like sensation - it comprises of the stimulation gained by, touching of distinctively shaped objects felt through a heavy material.
4. penetrable-surface sensation – experienced by the hand

Example -A physician palpates some part of the body to locate, through the outer layer of flesh, to identify some abnormal condition in deeper tissue.

When body and ambient temperature are equalized, the hand may be used as an instrument for the perception of the relative levels of heat and cold.

A Percussive Tool

The human hand can also be used as a percussion instrument..

A Vibratory Tool

Vibratory sensations, as perceived by the hand, are of importance in teaching the deaf to speak. Right hand are identical, the student has succeeded in imitating the sound. Helen Keller utilizes the vibratory phenomena when she "hears" music by placing her hand on the piano.

The Human Hand in Art

Through the ages, the human hand has appeared in all of the creative arts of every culture.

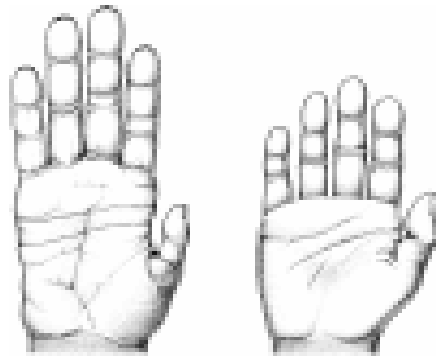


Fig. 1 Chimpanzee hand, a model for the hand of the hominid ancestor (left), and the human hand

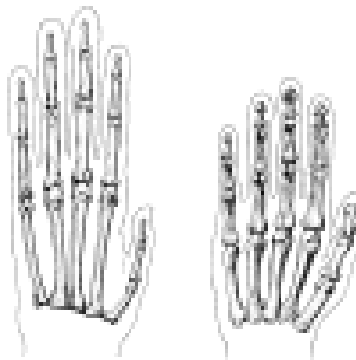


Fig. 2 Bones of the chimpanzee (left) and human hands.

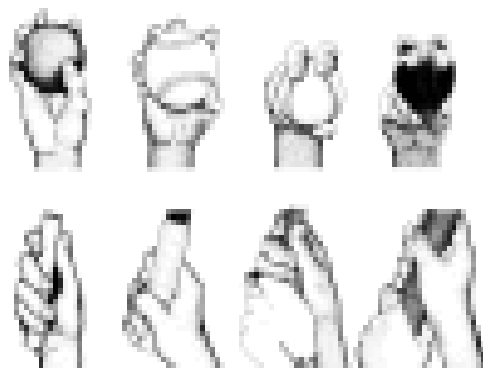


Fig. 3 Evolution, the human hand grip

EVOLUTION OF HAND

Man's Opposable Thumb

The powerful and well-developed thumb of man is one of his few uniquely human characteristics. Through successive stages of vertebrate evolution, the thumb has separated from the other fingers and developed specialized musculature.

Man's thumb, comparatively twice as long as that of some of the anthropoids, reveals a steady increase in absolute and relative length and at the same time the steady development of opposability, extensibility, and flexibility." In the ape, hands are hands by definition only. Although man's hand, the product of our evolutionary development.

The chimpanzee hand is taken as a model of the hominid ancestor hand. The fingers, metacarpal and carpal bones of the chimpanzee hand are elongated, The fingertips are cone-shaped, and lack broad apical tufts (Napier, 1960; Susman, 1988b, 1991). Owing to the transverse arrangement of the metacarpo-phalangeal articulations, there is a transverse skin crease across the palm . Thumb phalanges and metacarpals are slender and short (Susman, 1994) and the intrinsic muscles of the thumb, underlying the thenar region of the palm, are small (Marzke et al. 1992)., it cannot generate a firm pinch or squeeze (Marzke, 1992a, 1997; Marzke & Wullstein, 1996).

The human thumb is longer, the palm and fingers are shorter, and the fingers have lost their curvature (Susman, 1979). The distal phalanges have gained large apical tufts which support broad, palmar, fibrofatty pads that distribute pressure during forceful grasping and whose deformation accommodates the pads to uneven surfaces (Napier, 1965; Susman, 1979, 1988a; Marzke & Shackley, 1986). The thumb metacarpal articulates with the carpals in a saddle joint which in combination with remodelling in the metacarpal–phalangeal joint allows its distal pad to be placed against those of the other fingers, providing full opposability (Napier, 1955). The intrinsic thumb muscles are larger (Marzke, 1997) and three new muscles add strength and control to thumb movements.

The flexor pollicis longus muscle, absent in chimpanzees, is the most powerful thumb muscle in humans. It flexes the distal phalanx of the thumb and maintains the orientation of its pad toward the fingers against pressure. Also new are the deep head of the flexor pollicis brevis and the first volar interosseous muscle (Susman, 1994).

The palm has several derived features. Because the fourth and fifth metacarpals are progressively shorter than the third, there is an obliquity to the hand when it is flexed. This produces flexure creases that run obliquely, from the lower ulnar side of the palm to the upper radial side (Napier, 1993). The thenar and hypothenar eminences are enlarged by fat pads, which overlie the muscles.

Another unprecedented attribute of the human hand concerns finger rotation. When the fingers are flexed, they rotate towards the central axis so that the fingertips can meet the tip of the thumb. The metacarpal–hamate articulation permits supination of the fourth and fifth metacarpals, whereas the heads of the second and third metacarpals allow pronation of the proximal phalanges. Rotation is more pronounced for the two outermost fingers (Susman, 1979; Marzke, 1983, 1997).



Fig.4 12 week human embryo

Fig.5 9week human embryo

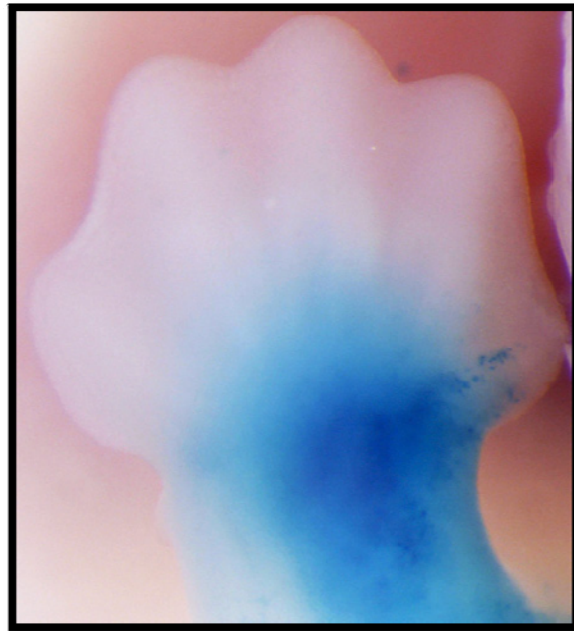


Fig. 6 48 days human embryo

EMBROLOGICAL DEVELOPMENT OF HAND

The upper extremity is first discretely visible as a bulge or limb bud that develops on the ventrolateral wall of the embryo on day 26 (4-mm crown-to-rump length)..

- Mesodermal layer will form the bones and connective tissues of limb covered by a layer of cuboidal ectoderm.
- Ectoderm at the distal border of the limb thickness and forms apical ectodermal ridge.

At the end of fourth week of development limb buds become visible as outpocketings from ventrolateral body wall

Onset of development of arm bud – 27 days

Well-developed arm bud – 28-30 days

Elongation of arm bud – 34-36 days

Formation of hand paddle – 34-38 days

Onset of finger separation – 38-40 days

Full separation of fingers – 50-52 days

POSITIONING AND REGULATION OF LIMB DEVELOPMENT

- After the development, the upper limb rotates 90 degrees laterally so the extensor muscles lie posterior and thumb lie laterally.
- The lower limb rotates 90 degrees medially. So Extensor muscles and big toe lies medially.

The development of upper limb and lower limb is similar except the morphogenesis of lower limb is approximately 1 to 2 days behind that of upper limb.

APOPTOSIS

- Lastly the process of apoptosis (programmed cell death) is involved in the development of upper limb. This process occurs in the interdigital spaces, axillary fold, within joint spaces.
- Apoptosis may occur by the cellular mechanisms of lysosomal enzyme release.

Intake of steroids, cigarette smoking during pregnancy causes congenital digital anomalies such as Polydactyly, Syndactyly, Adactyly.

FUNCTIONS OF HAND

Man is capable of achieving an extremely wide variety of functions and skills by the hand. The main functions of hand are as

- Grasp
- Support
- Striking movement
- Free movements
- Communication & expression
- Sensory reception.

GRASPING

Grasping are those prehension activities involved in taking , holding of an object between any two surfaces in the hand. Prehension can be categorized as power grip and precision handling.



Fig.7 Spherical Grip



Fig.8 Cylindrical Grip



Fig.7 Hook Grip



Fig.10 Lateral prehension

Power grip

It is generally a forceful act resulting in flexion at all fingers. When the thumb is used, it acts as a stabilizer to the object held between the fingers and most commonly the palm.

Power grip is the result of a sequence of opening the hand, positioning the fingers approaching the fingers to the object and maintaining a static phase that actually constitutes the grip .

There are four varieties of grip of power grips.

- ⇒ Cylindrical grip
- ⇒ Hook grip
- ⇒ Spherical grip
- ⇒ Lateral prehension

Cylindrical grip

It is almost exclusively uses flexors to carry the fingers around and maintain grasp on an object. Flexor digitorum profundus acts mainly in dynamic closing action. Flexor digitorum superficialis , interossei and hypothenar muscles are also active Cylindrical grip .

Hook grip

It is actually a specialized form of prehension. It is the function primarily of the fingers. It never includes thumb. The major muscle activity is provided by the Flexor digitorum profundus and Flexor digitorum superficialis.

Spherical grip

It uses extrinsic finger and thumb flexors, thenar muscles. It evokes more interossei activity. Opening of the hand during object approach and object release are primarily an extensor function of lumbricals, extensor digitorum communis and thumb extensors.



Fig.11 Pad to Pad-precision

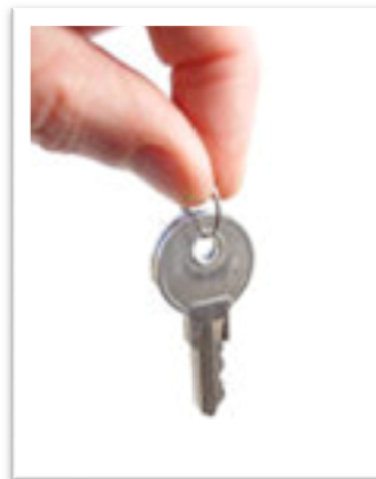


Fig.12 Tip to tip precision

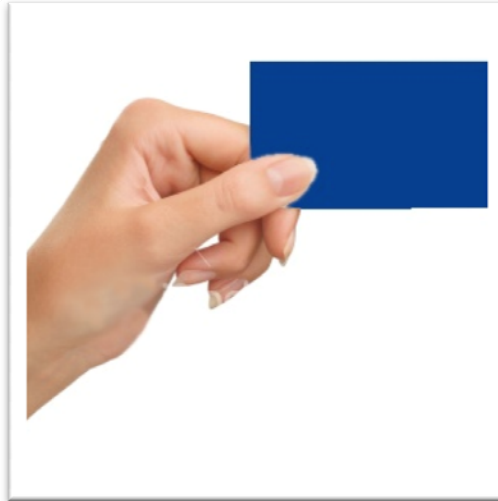


Fig.13 Pad to side precision

Lateral prehension

It is rather unique form of grasp. Contact occurs between two adjacent fingers. interossei, extensor digitorum communis and lumbricals are active during the Lateral prehension

Precision handling

- ☒ Pad to pad
- ☒ Pad to side
- ☒ Tip to tip

Support The hand may support the body weight. Example during crawling, activities like hand stands and Cartwheels. Hand also provides support to carry weights.

Striking movement The movements are accomplished with fingers either totally flexed as for a punch. The hand utilizing the strength of whole arm can be powerful weapon for both aggression and protection.

Free movements Fast intricate movements of fingers as in typing and playing musical instruments require each hand to be independent of the other. This is possible only when there is suitable posture of the trunk, which provides stability to the upper& lower arm.

Communication and Expression A variety of gestures is used in communication, from simple greetings to the complex sign language.

Sensory reception Sensibility of hand is the means by which cutaneous and proprioceptive stimuli are utilized.

- ✓ To achieved skilled motor function
- ✓ For awareness of touch for perception and testing of temperature etc.
- ✓ For recognition of objects.

DEVELOPMENT OF HAND FUNCTION

ONE TO THREE MONTHS Reflexively grasps finger or toy placed in hand.

THREE MONTHS Grasping reflex gone. Briefly holds small toy voluntarily when it is placed in the hand.

FOUR MONTHS Holds and shakes rattle. Brings hands together to play with them. Reaches for objects but frequently misses them.

FIVE MONTHS Grasps objects deliberately. Splashes water. Crumples paper.

SIX MONTHS Holds bottle. Grasps at own feet. May bring toes to mouth.

SEVEN MONTHS	Transfers toy from hand to hand. Bangs objects on table. Puts everything into the mouth. Loves playing with paper.
NINE MONTHS	Able to grasp small objects between thumb and forefinger.
TEN MONTHS	Points at objects with index finger. Lets go of objects deliberately.
ELEVEN MONTHS	Places object into another's hand when requested, but does not release.
TWELVE MONTHS	Places and releases object into another's hand when requested. Rolls ball on floor. Starts to hold <u>crayon</u> and mark paper with it.
FIFTEEN MONTHS	Builds tower of two blocks. Repeatedly throws objects on floor. Starts to be able to take off clothing, starting with shoes.
EIGHTEEN MONTHS	Builds tower of three blocks. Starts to feed self well with <u>spoon</u> . Turns book pages two or three at a time. Scribbles on paper.
TWO YEARS	Builds tower of six or seven blocks. Turns book pages one at a time. Turns door <u>knobs</u> and unscrews <u>jar</u> lids. Washes and dries hands. Uses spoon and fork well.
TWO AND A HALF YEARS	Builds tower of eight blocks. Holds pencil between fingers instead of grasping with fist.
THREE YEARS	Builds tower of nine or ten blocks. Puts on shoes and socks. Can button and unbutton. Carries containers with little spilling or dropping.
FOUR YEARS	Dresses self except for tying. Cuts with scissors, but not well. Washes and dries face.
FIVE YEARS	Dresses without help. Ties shoes. Prints simple letters.

NEED &

HYPOTHESIS

OF THE

STUDY

AIM OF THE STUDY

To evaluate the effectiveness of mirror box therapy on hand functions in patients with hemiplegia.

NEED FOR THE STUDY

Hand is the main manipulative organ and perform various functioning in our life. In hemiplegia there is loss of hand function. It causes permanent disability of patients due to poor distal recovery. Regaining hand functions is very difficult and challenging one in rehabilitation.

Recovery of hand functions is one of the neglected areas of rehabilitation due to its poor outcome inspite of intensive therapy and hence has become an object of frustration. Very few literatures describe the outcome of motor imagery training in hand rehabilitation in stroke patients and hence there is a need for the study to evaluate the effectiveness of Mirror box therapy, using motor imagery training on function of Hand in patients with Hemiplegia.

HYPOTHESIS OF STUDY

Null hypothesis (H0): There is no effectiveness of mirror box therapy with conventional physiotherapy on hand function in patients with hemiplegia.

Research hypothesis (H1): There is effectiveness of mirror box therapy with conventional physiotherapy on hand function in patients with hemiplegia.

OPERATIONAL DEFINITIONS

OPERATIONAL DEFINITIONS

Stroke is defined as rapidly developed clinical signs of a focal disturbance of cerebral function of presumed vascular origin and of more than 24 hrs of duration. **-World health organization.**

Stroke is the acute neurologic injury occurring as a result of one of these pathologic processes and is manifested either as brain infarction or hemorrhage. **-J.Philip kistler.**

Stroke is defined as a sudden non convulsive, focal neurological deficit resulting from a pathologic process of the blood vessels. **- C.M fisher.**

Cerebro vascular accident may be defined as the sudden onset of neurologic signs and symptoms resulting from a disturbance of blood supply to the brain. **– Suzanne Martin.**

Stroke is defined as damage of brain tissue either due to cerebral infarction or hemorrhage. **-R.G. Will & R.E Coll**

The Motor Assessment Scale (MAS) is a performance-based scale that was developed as a means of assessing everyday motor function in patients with stroke

-Carr, Shepherd, Nordholm, & Lynne, 1985.

The MAS is based on a task-oriented approach to evaluation that assesses performance of functional tasks rather than isolated patterns of movement

- Malouin, Pichard, Bonneau, Durand, & Corriveau, 1994.

A mirror box is a box with two mirrors in the center (one facing each way), invented and uses the principle of visual feedback to alleviate limb pain.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Lieberman et al (2009) states that mirror therapy, in addition to conventional therapy, improved hand function in patients with severe hemiparesis.

Suhaila Usuludin et al (2008) states that positive results in using mirror therapy in improving hand functions. Mirror therapy does not increase spasticity.

[Yavuzer g](#) **et al (2007) states** that in stroke patients, hand functioning improved more after mirror therapy in addition to a conventional rehabilitation program.

David Williams et al (2008) states that watching the movements of a healthy limb triggers "memories" of normal movement in the brain. The damaged limb then begins to mimic these normal movements, thereby accelerating recovery.

Nicole Grünert-Plüss et al (2009) states that of mirror therapy specifically in reducing pain, and improving function of movements.

Itsuki Imai et al (2008) states that Mirror therapy is more effective in stroke rehabilitation because of Sensorimotor Cortex Activation.

Ezendam D, et al (2009) states that mirror therapy is effective in upper limb treatment of stroke.

Cacchio A et al (2009) states that mirror therapy effectively reduces pain and enhances upper limb motor function in stroke patients.

Dohle C et al (2008) states that mirror therapy early after stroke is a promising method to improve sensory and attentional deficits and to support motor recovery in a distal plegic limb.

McCabe CS et al (2007) states that Mirror visual feedback was originally devised as a therapeutic tool to relieve pain and enhance movement in stroke.

Mulder T et al (2005) states that motor imagery or motor observation can lead to functional recovery and plastic changes in patients after stroke.

Rosén B et al (2005) states that treatment with a mirror gives an illusion of function in a missing or non-functioning hand that promotes motor recovery.

Garry MI et al (2000) states that excitability of primary motor cortex of ipsilateral side to a unilateral hand movement is facilitated by viewing a mirror reflection of the moving hand.

Greenspan AI et al (2007) states that, Mirror therapy facilitated employment of a motor copy strategy were increased functional use of the affected upper limb.

Carr et. AI 1985 has states that MAS is reliable and valid for testing, for the more task-oriented manner.

Malouin et. AI 1994 concludes that MAS takes a short time to administrate (10-15minutes) in experienced hands.

Lenon and Hastings 1996 states that MAS is a valid instrument.

Poole j I 1988 have established in their study the concurrent validity and inter rater reliability of Motor assessment scale for stroke patients .Individual items on MAS were also high and significant.

Izumi oht suru et al (2001) have stated in their study that intra rater and inter rater agreements were high for MAS and therefore it is a new reliable and valid scale used for stroke patients.

Sabari J S et al (2005) in their study have supported for the validity of hierarchical scoring criteria for upper limb MAS.

Lannin N (2004) demonstrated in his study that values of upper limb MAS was a responsive, valid reliable measure of upper limb function in adults following stroke.

DESIGN OF THE STUDY

DESIGN OF THE STUDY

Design of the study	:	Experimental Design
Study setting	:	Out patient Department of Physiotherapy, Adhiparasakthi Medical sciences and Research Institute. Melmaruvathur.
Study population-	:	Stroke patients referred to physiotherapy Department
Sampling technique	:	Simple Random
Sample Size	:	small (30 Patients)

Sampling Criteria

Inclusion criteria:

- *Age: 35 to 70 years.*
- *Sex: Both.*
- *Patient with hemiplegia due to cerebro vascular accident.*
- *Both side right and left hemiplegia.*
- *Both ischemic and hemorrhagic stroke.*
- *Time since onset of stroke 3 months to 2 years.*
- Patient who had Motor assessment Scale score of 6 in upper arm function.
- No other motor rehabilitative therapy during 6 week participation.
- Willingness to agree the intervention and testing procedures.

Exclusion criteria:

- Serious cognitive deficits,
- Excessive spasticity at the elbow, wrist, or hand,
- History of botulinum toxin injection in affected upper extremity in the past 4 months
- Less than 45 degrees of passive shoulder flexion.
- Global or receptive aphasia present on physical exam.
- Hemispatial neglect present on physical exam.
- Patient participating in constraint-induced therapy during study time period .
- Severe visual deficits or visual field deficits as determined by ability to ascertain number of fingers held up on visual field testing
- Deformity/amputation of any upper limb . ‘
- Shoulder subluxation (or) dislocation in any extremity.
- Unhealed fracture in any upper extremity.
- Patient who had recent Shoulder surgery.
- Patient had elbow wrist and finger flexion contracture.

Variable of the study : *Independent Variable:* -Mirror Box therapy
Dependent Variable: - Hand function

Outcome measurement Tool

Motor Assessment Scale.

Materials Used

- Mirror Box
- General neurological assessment chart
- Hand function assessment chart
- Peg boards.
- Squeeze ball
- Hand exerciser
- Marbles
- Pen & paper
- Swiss ball
- Playing cards
- Spoon
- Cup filled with water.
- Wooden Table
- Chair

METHODOLOGY

METHODOLOGY

Based on the selection criteria, 30 subjects with hemiplegia were selected. After obtaining informed consent initial neurological examination & hand function evaluation was done and they were equally divided as Group A and Group B. Hand function of these subjects were measured using Motor Assessment Scale.

Experimental Group received conventional physiotherapy with Mirror box therapy
Control Group received conventional physiotherapy alone.

Treatment was given 5 sessions a week for 6 weeks each session had a duration of 45 Minutes with few minutes interval in between the treatment programs. Assistance was given to the affected hand, if the patient had difficulty in performing task. If the patient was able to do the task then assistance was withdrawn. Hand function was measured before and after treatment by using Motor Assessment Scale. Based on the pre-test and post test scores data was analyzed and results were interpreted.

- ✓ Experimental Group received conventional physiotherapy with Mirror box therapy.
- ✓ Control Group received conventional physiotherapy alone.



Fig.14 Mirror Box Therapy



Fig.15 Hand Function Activities Using Marbles

TREATMENT

TECHNIQUE

Mirror box therapy

Patients who underwent Mirror box therapy should remove the following things, they are as follows:

- Wrist watch
- Bangles
- Rings
- Bracelet, etc.,

Procedure

The affected hand was held inside the mirror box. The unaffected hand was placed outside the box in such a way that the image should be viewed through the mirror. Symmetrical movements were performed by both the hands simultaneously.

The following movements were performed in the mirror box. They are as follows:

- Forearm pronation to supination
- Wrist extension
- Finger spreading when wrist is in neutral
- Fist closure
- Thumb Abduction
- Thumb Apposition

Each movement was performed at the rate of 15 times.



Fig.16 Hand Function Activites



Fig.17 Hand Function Activites Using Squeeze Ball

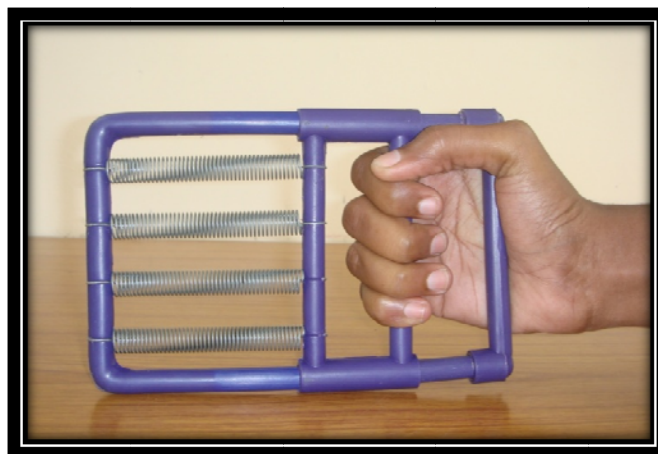


Fig.18 Hand Function Activites Using Hand Exerciser

Conventional physiotherapy

- Passive stretching of biceps, supinator, wrist and finger flexors.
- Joint loading can be done in quadripod position for 10 minutes.
- Facilitation of wrist extension and radial deviation.
- Supination Training.
- Peg board activities.

Various movement strategies of hand were trained in a task oriented manner. They are as follows:

- Ball bouncing in standing
- Grasp and release of squeeze ball
- Water filling with the help of spoon
- Drawing activity
 - To draw Horizontal line
 - To draw vertical line
 - To draw circle
 - To draw Triangle
 - To draw Square
- Card shifting activity by using playing cards.
- Picking of marbles.
- Hand Exerciser activity.

OBSERVATION & ANALYSIS

DATA COLLECTION
Table 1

S.No	CONTROL GROUP				EXPERIMENTAL GROUP			
	Hand movements		Advanced hand activities		Hand movements		Advanced hand activities	
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test
1.	1	3	0	1	1	6	1	5
2.	0	1	0	0	0	4	0	2
3.	1	2	1	1	3	6	2	5
4.	1	4	0	2	1	5	0	3
5.	1	3	1	2	2	6	0	3
6.	2	3	1	3	0	4	0	2
7.	0	1	0	0	1	5	1	3
8.	1	4	0	2	1	6	1	5
9.	1	3	0	1	0	3	0	2
10.	1	5	1	4	3	6	1	6
11.	1	6	1	4	1	5	1	4
12.	2	4	1	3	1	6	0	5
13.	0	2	0	1	0	3	0	2
14.	3	4	2	2	2	4	1	2
15.	0	1	0	0	1	3	0	2

ANALYTICAL TOOL

In order to verify the investigation, the data was subjected to several analyses

The statistical procedures and their formulae.

$$\text{Mean} = \frac{\sum x}{N}$$

$$\text{S.D} = \sqrt{\frac{\sum x^2}{N} - \left(\frac{\sum x}{N}\right)^2}$$

$$\text{Paired 't' test} = \frac{\bar{D}}{S/\sqrt{N}}$$

$$\text{Two samples 't' test} = \frac{|\bar{X}_1 - \bar{X}_2|}{S \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$\text{Where } S = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

DATA ANALYSIS

Descriptive statistics

Distribution of hand movements scores (MAS) before and after treatment in control group.

Table 2

	N	Minimum	Maximum	S.D
Pretest	15	0	3	0.8164
Posttest	15	1	6	1.4360

Distribution of hand movements scores (MAS) before and after treatment in experimental group.

Table 3

	N	Minimum	Maximum	S.D
Pretest	15	0	3	0.9568
Post test	15	3	6	1.1661

Table 4

Distribution of Advanced hand activities scores (MAS) before and after treatment in control group

	N	Minimum	Maximum	S.D
pretest	15	0	2	0.6182
Posttest	15	0	4	1.2892

Distribution of Advanced hand activities scores (MAS) before and after treatment in Experimental group.

Table 5

	N	Minimum	Maximum	S.D
pretest	15	0	2	0.6182
Posttest	15	2	6	1.4047

INFERENTIAL STATISTICS

Comparing Hand movements (MAS) pre test & post test scores in control group.

Table 6

Mean	S.D	Standard Error Mean	't'value	df	P
2.07	1.181	0.316	6.54	14	0.0001

Comparing Hand movements (MAS) pretest & post test scores experimental in-group.

Table 7

Mean	S.D	Standard Error Mean	't'value	df	P
3.67	0.942	0.252	14.55	14	0.0001

Comparing Advanced Hand activities (MAS) pre test & post test scores control in-group.

Table 8

Mean	S.D	Standard Error Mean	't'value	df	P
1.20	1.045	0.279	4.294	14	0.0007

Comparing Advanced Hand, activities (MAS) pre test & post test scores in experimental group.

Table 9

Mean	S.D	Standard Error Mean	't' value	df	P
2.87	1.19	0.307	9.351	14	0.0001

Two sample 't' test

Comparing values of hand movements (MAS) in experimental and control groups.

Table 10

	't' value	df	Table value	P
Hand movements	3.505	28	1.70	0.0008

Comparing values of Advanced hand activities (MAS) in experimental and control groups.

Table 11

	't' value	df	Table value	P
Hand movements	3.27	28	1.70	0.001

By comparing control and experimental group, experimental group is more effective than the control group.

RESULT

RESULT

30 Samples were taken to evaluate the effectiveness of mirror box therapy on hand function in patients with hemiplegia.

Treatment was given for 5 sessions a week for 6 weeks. Each session had a duration of 45 Minutes. Hand function was measured before and after treatment by using Motor Assessment Scale.

The pre test & post test scores of hand function within experimental and control groups were compared and analyzed using paired 't' test. This test has showed significant difference between pre& post test scores of hand function in both the groups.

Two sample't' test was used to compare the results between experimental and control groups in hand function. So there is acceptance of research hypothesis (H_1) and rejection of Null hypothesis (H_0).

DISCUSSION OF THE STUDY

DISCUSSION OF THE STUDY

Mirror box therapy involves visualizing and undertaking symmetrical bilateral movements. The affected limb is placed inside the mirror box with the image of the unaffected limb being reflected in the mirror. As the unaffected limb performs a task, the brain associates the feeling of movement with the visual image and transfers the perception of movement onto the affected limb.

Our perceptions of the motor acts and emotive reactions of others appear to be united by a mirror mechanism that permits our brain to immediately understand what we are seeing, feeling, or imagining others to be doing, as it triggers the same neural structures... that are responsible for our own actions and emotions.

The 1980s and 1990s, Giacomo Rizzolatti was working with Leonardo Fogassi and Vittorio Gallese at the university in Parma, Italy had first discovered mirror neurons in macaque monkey.

Mirror neurons are the cells with extraordinarily complex response characteristics, closely linked to visual observation of goal-directed actions." (Miall 2003)

Premotor cortex – Lateral part of frontal cortex, in front of primary motor cortex

Area 46: Working memory of object location, Areas 5 & 7: Integrating sensory modalities in motor cortex. And Loops with basal ganglia and cerebellum via thalamus these brain regions are likely to contain mirror neurons and have been defined as the human mirror neuron system. (Kandel, Schwartz, and Jessel 2000)

Mirror neurons are presumed to be abundant in brain regions responsible for planning and initiating actions, including the primary motor cortex, the premotor cortex and supplementary motor areas.

Rizzolatti and Corrado Sinigaglia write in their new book, *Mirrors in the Brain*, Our actions depends first of all on our motor neurons."^[5] Our abilities to understand and react to the emotions of others may depend on the brain's ability to imitate the neuronal activity of the individual being observed.

Mirror neurons continue to light up neuroscientists' imaginations, as several new studies show that the nerve cells respond to more than just visual stimuli.

Mirror neurons are multimodal — they are activated by not just by watching actions, but also by hearing and reading about them (Jeanene Swanson, 2006)

“Mirror neurons,” a widely dispersed class of brain cells that operate like neural WiFi. Mirror neurons track the emotional flow, movement and even intentions of the person And replicate this sensed state in our own brain by stirring in our brain the same areas active in the other person.

Ramachandran is investigating mirror neurons that are found abundantly in humans and to a lesser extent in other primates.

Suresh Muthukumaraswamy, PhD, at Cardiff University, found that the mirror system is activated when we watch specific actions, even when we are concentrating on a separate task

Mirror neurons necessarily involve interactions between multiple modalities—vision, motor commands and proprioception. The mirror provides patients with “proper” visual input—the mirror reflection of the moving good arm looks like the affected arm moving correctly—and perhaps “substitutes” for the often decreased or absent proprioceptive input. Use of the mirror may also help recruit the premotor cortex to help with motor rehabilitation. It also helps to mimic the relative speeds of movement of the normal and the affected limb implicitly generated by a subject using a mirror. These features aid in recruitment of ipsilateral pathways using mirrors.

premotor cortex has a number of features suggesting it might possibly be a link from the visual image in the mirror to motor rehabilitation following stroke.

Visual feedback restores the information flow from the posterior parietal cortex to the pre motor cortex (Altschuler et al 1999).

Recruiting the premotor cortex or rebuilding the motor programme in the premotor cortex by providing visual feedback could facilitate the limb movement(Rothgangel 2004)

It help to increase contributions of the descending corticospinal tracts and more bilateral control of movement than the motor cortex itself.

Thus, the data presented provide convincing support for the inclusion of mirror box therapy as a part of rehabilitation intervention for those with impaired hand functions in cerebro vascular accident.

LIMITATION OF STUDY

LIMITATIONS

- Age and gender as a variable was not controlled in the study.
- Premorbid fitness levels of the subjects were not taken into account.
- Sample size was small .
- Environmental and social parameters were not controlled.
- The type of stroke was not under controlled.
- The duration of the study was short (6 weeks).
- The side of Hemiplegia was not under controlled.
- The involvement of artery was not specified.

FUTURE SUGGESTIONS

- The study may be conducted in large sample size.
- Duration of the study can be extended and further follow up may be done.
- Hand dominance can be taken into account.
- Studies can take into account the parameters like type and side of stroke.
- Studies can be conducted on patients in acute stage.

CONCLUSION

CONCLUSION

Based on above result s it may be concluded that mirror box therapy with conventional physiotherapy improves hand functions in patients with hemiplegia.

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APPENDIX

APPENDIX I

NEUROLOGICAL ASSESSMENT FORM

Name

Age

Sex

Occupation

Address

Ph.no

Date of assessment

O.p no/l.p no

Diagnosis

Side of lesion

Location of lesion

Type of lesion

Chief complaint

present medical history

Onset
Duration
Progression of illness

past medical history

Previous episodes of illness
Treatment given
Prognosis

Associated medical problem

Hypertension
Diabetes mellitus

Personal history

Smoking
Alcoholism
Duration of such habits
Frequency of usage

vital signs

- Blood pressure
- Pulse rate
- Respiratory rate
- Temperature

ON OBSERVATION

- Facial abnormalities
- Postural abnormalities
- Attitude of limbs
- Mode of ambulation
- Use of any external appliances
- Gait

On Palpation

Palpate shoulder joint to rule out subluxation

ON EXAMINATION

- State of consciousness
- Memory
 - Short term
 - Long term
- Speech language

Cranial Nerve Examination

Emotional state

- Anxiety:
- Depression:
- Slowness of movement/response:
- Emotional behavior:
- Uninhibited behavior:
- Personality type or change:

SENSORY EVALUATION

Superficial
Deep
Cortical

Motor Examination

Tone

- **Reflexes**
 - Superficial
 - Abdominal
 - Plantar

Deep tendon reflexes

- Biceps jerk
- Triceps jerk
- Knee jerk

Voluntary movement pattern

- Upper limb
- Lower limb

Balance

- Static:
- Dynamic:

Co-ordination

Upper limb:
Lower limb:

APPENDIX- II

HAND FUNCTION ASSESSMENT CHART

Name

Age

Sex

Occupation

Date of onset

Side affected

Diagnosis

Chief complaint

On observation

Any deformity or contracture in hand

Any orthotic appliances used for hand

Examination

On sensory Examination

- Pain
- Temperature
- Light touch
- Crude touch
- Joint position sense
- Kinesthesia
- Vibration
- Two point localization
- Two point discrimination
- Stereo gnosis
-

Motor examination

Wrist

Wrist stabilization for grasp

Elbow flexed
Elbow extended

Wrist flexion & extension

Elbow flexed
Elbow extended

Fist closure

Wrist circumduction

Digits

Mass grasp

Mass extension

Analysis of individual finger movements

Non prehensile activity

- Clapping
- Tapping
- Scratching

Prehensile activity

- Lateral prehension
- Cylindrical grip
- Spherical grip
- Hook grip

Precision

- Pad to pad
- Pad to side

- Tip to tip

Cascading

Manipulatory skills

Translation

With thumb support
Without thumb support

Rotation

With thumb support
Without thumb support

Shift

With thumb support
Without thumb support

Skilled activity- hand writing

- Position of whole upper limb writing
- Grasp held by the patient when holding the pen
- Can copy horizontal line
- Can copy vertical line
- Can copy triangle.

Functional evaluation of hand - MAS

APPENDIX III

MOTOR ASSESSMENT SCALE

Patient Name: _____

Therapist: _____

*If the patient cannot complete any part of a section score a zero (0) for that section.
There are 9 sections in all.*

Supine to Side-lying onto intact side (starting position: supine with knees straight)

1. Uses intact arm to pull body toward intact side. Uses intact leg to hook impaired leg to pull it over.
2. Actively moves impaired leg across body to roll but leaves impaired arm behind.
3. Impaired arm is lifted across body with other arm. Impaired leg moves actively & body follows as a block.
4. Actively moves impaired arm across body. The rest of the body moves as a block.
5. Actively moves impaired arm and leg rolling to intact side but overbalances.
6. Rolls to intact side in 3 seconds without use of hands.

Supine to Sitting over side of bed

1. Pt assisted to the side-lying position: Patient lifts head sideways but can't sit up.
2. Pt may be assisted to side-lying & is assisted to sitting but has head control throughout.
3. Pt may be assisted to side-lying & is assisted with lowering LEs off bed to assume sitting.
4. Pt may be assisted to side-lying but is able to sit up without help.
5. Pt able to move from supine to sitting without help.
6. Pt able to move from supine to sitting without help in 10 seconds.

Balance Sitting

1. Pt is assisted to sitting and needs support to remain sitting.
2. Pt sits unsupported for 10 seconds with arms folded, knees and feet together & feet on the floor.
3. Pt sits unsupported with weight shifted forward and evenly distributed over both hips / legs. Head and thoracic spine extended.
4. Sits unsupported with feet together on the floor. Hands resting on thighs. Without moving the legs the patient turns the head and trunk to look behind the right and left shoulders.
5. Sits unsupported with feet together on the floor. Without allowing the legs or feet to move & without holding on the patient must reach forward to touch the floor (10 cm or 4 inches in front of them) The affected arm may be supported if necessary.
6. Sits on stool unsupported with feet on the floor. Pt reaches sideways without moving the legs or holding on and returns to sitting position. Support affected arm if needed.

Sitting to Standing

1. Pt assisted to standing – any method.
2. Pt assisted to standing. The patient's weight is unevenly distributed & may use hands for support.
3. Pt stands up. The patient's weight is evenly distributed but hips and knees are flexed – No use of hands for support.
4. Pt stands up. Remains standing for 5 seconds with hips and knees extended with weight evenly distributed.
5. Pt stands up and sits down again. When standing hips & knees are extended with weight evenly distributed
6. Pt stands up and sits down again 3 x in 10 seconds with hips & knees extended & weight evenly distributed

Walking

1. With assistance the patient stands on affected leg with the affected weight bearing hip extended and steps forward with the intact leg.
2. Walks with the assistance of one person.
3. Walks 10 feet or 3 meters without assistance but with an assistive device.
4. Walks 16 feet or 5 meters without a device or assistance in 15 seconds.
5. Walks 33 feet or 10 meters without assistance or a device. Is able to pick up a small object from the floor with either hand and walk back in 25 seconds.
6. Walks up and down 4 steps with or without a device but without holding on to a rail 3 x in 35 seconds.

Upper Arm Function

1. Supine: Therapist places affected arm in 90 degrees shoulder flexion and holds elbow in extension – hand toward ceiling.

The patient protracts the affected shoulder actively.

2. Supine: Therapist places affected arm in above position. The patient must maintain the position for 2 seconds with some external rotation and with the elbow in at least 20 degrees of full extension.

3. Supine: Patient assumes above position and brings hand to forehead and extends the arm again. (flexion & extension of elbow) Therapist may assist with supination of forearm.

4. Sitting: Therapist places affected arm in 90 degrees of forward flexion. Patient must hold the affected arm in position for 2 seconds with some shoulder external rotation and forearm supination. No excessive shoulder elevation or pronation.

5. Sitting: Patient lifts affected arm to 90 degrees forward flexion - holds it there for 10 seconds and then lowers it with some shoulder external rotation and forearm supination. No pronation.

6. Standing: Have patient's affected arm abducted to 90 degrees with palm flat against wall. Patient must maintain arm position while turning body toward the wall.

Hand Movements

1. Sitting at a table (Wrist Extension): Affected forearm resting on table. Place cylindrical object in palm of patient's hand.

Patient asked to lift object off table by extending the wrist – no elbow flexion allowed.

2. Sitting at a table (Radial Deviation of Wrist): Therapist should place forearm with ulnar side on table in mid-pronation / supination position. Thumb in line with forearm and wrist in extension. Fingers around cylindrical object. Patient is asked to lift hand off table. No wrist flexion or extension.
3. Sitting (Pronation / Supination): Affected arm on table with elbow unsupported at side. Patient asked to supinate and pronate forearm ($\frac{3}{4}$ range acceptable).
4. Place a 5 inch ball on the table so that the patient has to reach forward with arms extended to reach it. Have the patient reach forward with shoulders protracted, elbows extended, wrist in neutral or extended, pick up the ball with both hands and put it back down in the same spot.
5. Have the patient pick up a polystyrene cup with their affected hand and put it on the table on the other side of their body without any alteration to the cup.
6. Continuous opposition of thumb to each finger 14 x in 10 seconds. Each finger in turn taps the thumb, starting with the index finger. Do not allow thumb to slide from one finger to the other or go backwards.

Advanced Hand Activities

1. Have the patient reach forward to pick up the top of a pen with their affected hand, bring the affected arm back to their side and put the pen cap down in front of them.
2. Place 8 jellybeans, (beans), in a teacup an arms length away on the affected side. Place another teacup an arms length away on the intact side. Have the patient pick up one jellybean with their affected hand and place the jellybean in the cup on the intact side.

3. Draw a vertical line on a piece of paper. Have the patient draw horizontal lines to touch the vertical line. The goal is 10 lines in 20 seconds with at least 5 lines stopping at the vertical.
4. Have the patient pick up a pen/pencil with their affected hand, hold the pen as for writing, and position it without assistance and make rapid consecutive dots (not strokes) on a sheet of paper. Goal: at least 2 dots a second for 5 seconds.
5. Have the patient take a dessert spoon of liquid to their mouth with their affected hand without lowering the head toward the spoon or spilling.
6. Have the patient hold a comb and comb the back of their head with the affected arm in abduction and external rotation, forearm in supination.

APPENDIX IV

HOME PROGRAMME

- Tying shoes
- Zipping and unzipping
- Buckling and unbuckling
- Writing legibly and without significant muscle fatigue
- Playing games that require precise hand and finger control
- Drawing, painting, and coloring
- Manipulating buttons and snaps
- Putting small objects together
- Doing puzzles
- Making crafts
- Using scissors
- Manipulating small objects such as coins
- Opening and closing objects
- Picking up and holding onto small objects
- Developing and maintaining an effective and proper pencil grip
- Pinching objects between fingers
- Using locks and keys
- Being able to isolate finger movements (i.e., using one finger at a time, such as in playing the piano or typing)
- Turning things over or turning pages of a book
- Holding and using utensils properly and effectively
- Screwing and unscrewing
- Doing anything that requires small precise hand and finger movements .

APPENDIX V

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

1. Title of the study A study on the effectiveness of mirror box therapy on hand function in patients with Hemiplegia.
2. You are invited to participate in a research study that evaluated that the effectiveness of mirror box therapy in hand function along with conventional physiotherapy.
3. You have been invited to participate based on the criteria of the study.
4. Your participation would require attendance during the treatment session lasting approximately 1 hour per day.
5. Prior to your participation an investigator will take a brief medical history to determine whether you had any medical problems which would make you ineligible to participate number so that your name will not be associated with any of the findings of this study.
6. The research procedure consists of functional movements of hand should be done simultaneously in both the hands using mirror box. In addition to that conventional physiotherapy] are also given. Hand function can be evaluated using Motor assessment scale.
7. If you have questions about this research or need to report any problem related to your participation in this study kindly inform me. Your participation in this research is voluntary and your decision whether or not to participate in the study, you have the rights to withdraw from the study at any time affecting your standing at the institution.

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

I Voluntarily consent to participate in this research study as described .I has a chance to ask questions of the research and have any questions answered to my satisfaction.

Signature of participant

Signature of researcher

Date:

Place: